

RESUSCITATION

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BY THE SAME AUTHOR

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RESUSCITATION

FROM

ELECTRIC SHOCK, TRAUMATIC SHOCK, DROWNING,
ASPHYXIATION FROM ANY CAUSE

*BY MEANS OF ARTIFICIAL RESPIRATION BY
THE PRONE PRESSURE (SCHAEFER) METHOD*

WITH ANATOMICAL DETAILS OF THE METHOD, AND
COMPLETE DIRECTIONS FOR SELF-INSTRUCTION

BY

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BY

CHARLES A. LAUFFER

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PREFACE TO THE SECOND EDITION

This volume has met with public favor beyond our expectations; the humane sentiment of our times, calling for the conservation of human life even though apparently extinct, by means of "the best methods" of artificial respiration, is addressed in these pages.

The extreme folly of leaving a man unaided, who is unconscious from Electric Shock, or whose respiration is suspended from whatever cause, while "a messenger is sent in haste four miles for a pulmotor," is adequately treated in an addenda relating to this mechanism.

When the hands are properly placed on the outer ends of the patient's lowest ribs, far removed from the spine, with the thumbs turned out, so that the bones of the forearm wind around each other, then the exertion directed from the shoulder, as the weight of the body is swung forward, will drive out more air than any device yet invented, and

will give better hopes for the recovery of the patient. The arms are thus maintained straight and rigid, and the maximum respiratory exchange is obtained for the patient with the least exhaustion of the operator.

Other addenda include a synopsis of the method for the busy man, a Resuscitation Card, additional data on the success attending this method in specific cases, and the need of greater publicity.

The adoption of this method by the Navy, the Coast Guard service, the Bureau of Mines, also by the Safety Committees of Corporations employing near five million men, has justified our prediction that the Prone Pressure method would eventually be universally adopted "as the standard method of resuscitation."

More laymen than physicians in the United States have been instructed in this method, and are competent to render such assistance. It is a crime against humanity for a policeman to shove back a comrade and deny him the right to resuscitate a man unconscious from "smoke," or "electric shock," *because he has no medical degree.*

The future may bring us more light and more knowledge, but for the present, after summarizing the available evidence pro and con, the manual method seems better than the

mechanical, and of the six manual methods, the Prone Pressure (or Schaefer), is "the standard method."

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February 8, 1915.

PREFACE

The universal adoption of Prone Pressure as the standard method of resuscitation seems assured. Its simplicity and efficiency commend its general adoption; its successful achievements are numerous. A conflict of methods may cause dangerous delay, and in any given case is a misfortune. The one-man method, the method that requires no equipment other than the hands of a man's friend, is based on sound anatomical principles.

The paper herewith presented was read before the Philadelphia Electric Company Section of the National Electric Light Association, at an enthusiastic meeting that crowded Franklin Institute, November 18, 1912.

The material is presented in a form suitable for those who have neglected the study of the mechanism of the human engine, as well as for those whose knowledge of human anatomy needs refreshing

While the method can be fully described in one hundred words, there are many details that deserve more adequate description, if the memory is to be impressed and blunders obviated.

The instances of success in resuscitation are related so as to inspire others to like humane achievement, and the purpose of the author will be attained, if the booklet contributes to that end.

CHARLES A. LAUFFER, M.D.

WILKINSBURG (PITTSBURGH), PA

Dec. 2, 1912.

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RESUSCITATION

INSTRUCTION IN RESUSCITATION

I accepted with genuine pleasure the invitation of your chairman to speak on the subject of artificial respiration, along the same lines as the paper I prepared for The Pennsylvania Electric Association, at Bedford Springs, in September of this year. During the past three years I have neglected no opportunity for advancing the cause of artificial respiration by the Prone Pressure (or Schaefer) method, both by writing and speaking, as well as by demonstration. I have written up the Prone Pressure method for five magazines, and also included the subject in a booklet on "ELECTRICAL INJURIES," and have trained fully 2000 men in the art and instructed them in the theory of the Prone Pressure method.

It is a fortunate trend of public opinion that makes it incumbent on every intelli-

gent citizen to know how to give artificial respiration. It is no longer exclusively the role of a physician to give artificial respiration, for if men in dangerous trades do not think enough of one another to practice the method, in anticipation of any possible emergency, why should physicians bother about it? Why should a doctor risk breaking his neck in a mad race to reach the scene of disaster too late to be of any service? Artificial respiration must be begun instantly by the victim's comrades, and the supplemental assistance is peculiarly the province of the physician.

While there are more physicians per 100,000 of population in the United States than in any other country, a physician, like the policeman, is invariably out of reach when an emergency arises. Laymen simply must learn how to bring back life in an apparently dead body, else the number of fatalities from these tragic accidents, fatal because of the ignorance of bystanders, will continue to appall.

Some stand-patter may insist that we are hearing too much about resuscitation these days; that a generation ago the general public was not expected to know anything about artificial respiration. We should realize that we are living in the midst of more dangers

than a generation ago; the score of gases encountered in the industries and in our homes, the wide application of electricity, combined with other causes, have added to the perils of modern life; never before was the diffusion of the knowledge of resuscitation so necessary as in the present age.

FORETHOUGHT

Complete details of how to rescue a comrade from a dangerous situation must be thought out in advance; the location of switches, and modes of short-circuiting lines, and of separating a body from an electrical contact without danger to the rescuer, must be studied out in advance by the individuals of each department of electrical service. The same may be said for workers in mines, for gas men, and for every line of industry. With adequate circumspection and forethought, fatalities can be much reduced. And when these apparent calamities do occur, consternation seizes especially those not adequately trained to cope with the responsibilities of the situation. Artificial respiration should be practiced by everybody, in anticipation of any such emergency.

SUCCESSFUL RESULTS

Among the men whom I have instructed in this method, six to our knowledge have had occasion to use it; three in the factory, namely, a case of concussion of the brain with unconsciousness and failure of both heart and respiration, requiring an hour's time; and two severe cases of electric shock, with complete success in each one of these three cases. And three cases reported outside of the factory, namely, one case of suffocation by smoke—life seemed extinct, when the firemen rescued the victim from the burning building, but a Westinghouse man in the crowd knew the Prone Pressure method, and revived him before the ambulance and police surgeon arrived; a second case was that of a man hit on the head with a baseball; respiration was so completely arrested that it seemed he would have died, but for the prompt assistance by artificial respiration on the part of one of our men; a third case was one of drowning—an employee who had profited by the instruction taught the method to his

son, and the son's knowledge was the means of saving the life of a comrade from drowning. All three cases outside of the works were completely successful. In these six cases, from divergent conditions, requiring artificial respiration, the percentage of recovery is 100. Saving six lives in two years is worth while, and these 2000 trained men in the rest of their lives may have much more opportunity for this service to their fellows.

The sacrifice of life in our country resulting from ignorance of methods of resuscitation challenges efforts at conservation. It is equally necessary to know how to give artificial respiration whether in industry or in sportsmanship. A man suffering from electric shock will perish unless revived by some manual or mechanical method of artificial respiration; and so may the man who has been pinned under his automobile, or hit over his solar plexus in a boxing bout.

I know a man who has resuscitated six victims of electric shock, all of them fatal cases but for his prompt and efficient efforts at artificial respiration. Voltages commonly exceed 130,000 in his department, yet his percentage of recoveries is 100. This man is an enthusiastic advocate of the Prone Pressure method.

Methods of resuscitation succeed in elec-

tric shock because the victim commonly receives a mere leakage current from the line; the contact is brief and imperfect, and the dry, calloused skin, as of the palm, offers an exceedingly high electrical resistance. The frequent successes attending efforts at resuscitation have brought the subject of artificial respiration into national prominence.

TYPES OF CASES REQUIRING RESUSCITATION

(I) Electrical men in their zeal for artificial respiration forget that gas men need to know the method too, as Electric Shock is not the sole condition requiring methods of resuscitation. On the contrary the fact deserves emphasis, that a working knowledge of a good method of artificial respiration is essential in every walk of life. No man can predict whether or not his failure to learn how to give artificial respiration may any day be responsible for loss of life.

(II) Asphyxiation arises when the body is deprived of air; it is due to the presence of gases that will not support life—a man must have a constant supply of oxygen: (1) Illuminating gas, (2) the gases of mines, (3) carbon-monoxide from the defective oxidation in a stove, (4) the ammonia fumes of an ice plant, (5) gasoline fumes of a garage, (6) the gases of a blast furnace, (7) of molten brass, (8) of the manufacture of gas, (9) certain elements freed from their compounds, as bromine and chlorine, (10) certain dis-

infecting agents such as sulphur dioxide and formaldehyde, (11) the carbon dioxide waste from whatever source, (12) other non-respirable gases and fumes in various chemical processes, (13) exclusion of air, as in a bank vault, (14) confined air, as in the compartments of ships, (15) sewer gas, (16) suffocation by smoke; all these are among the causes that produce asphyxiation, and require artificial respiration.

Whenever from such a cause the face becomes pale or livid, unconsciousness intervenes, and breathing becomes irregular, or ceases, we know it is a case for artificial respiration.

(III) Inhalations of chloroform and ether may similarly cause a suspension of breathing, requiring instant withdrawal of the anaesthetic and immediate assistance in the way of artificial respiration.

(IV) Overdoses of laudanum, likewise, may cause failure of respiration, and among various measures of restoration, artificial respiration is often life-saving.

(V) Apparent death from Drowning is treated in precisely the same manner as electric shock, and, by the Prone Pressure (or Schaefer) method, one man alone can resuscitate a drowning comrade. Every time pressure is made upon the floating ribs of

the patient, water and mucus are expelled from his lungs and air passages, hence by this method the prospects of restoring the victim are most favorable.

(VI) In the shock produced by a heavy blow under the belt (a solar plexus blow), or on the jaw or neck, or as the result of a blow upon the head, "the wind is often knocked out of a man." The condition of Traumatic Shock produced by such an injury may prove fatal unless the victim is assisted. He must be made to breathe until his disturbed nerve centers recover their normal functions.

It should be remembered that while we can live forty days without food, and two days without water, life is in jeopardy when we are deprived of air for two minutes. On analysis, each of the six types of cases requiring resuscitation will be seen to be identical: the oxygen supply is cut off—in some cases by the substitution of noxious gases, in some by violent injuries, in others by a failure to eliminate the carbon dioxide produced in our tissues, which gas, when retained, paralyzes the respiratory center in the medulla (the physiological coördinating center of the brain), and inhibits the action of the diaphragm. They are all alike, in that the diaphragm is paralyzed (inhibited).

MECHANISM OF RESPIRATION

Without entering on the nervous mechanism of the respiration, and without considering the accessory respiratory muscles, it is in order to consider the gross anatomy involved in breathing.

The action of the diaphragm is well illustrated by the familiar bell jar experiment. (See illustration.) The lungs of a cat are carefully removed; this is readily accomplished by piercing the diaphragm, so as to allow the lungs to collapse. Each pleural cavity is nearly a perfect vacuum, so that the condition in nature is better than the experiment in the jar. The lungs so removed are tied to a piece of glass tubing, and the tubing is carried up through the rubber stopper of the bell jar. Over the bottom of the bell jar a sheet of rubber is stretched and fastened so as to be air-tight.

When this rubber is drawn down, the air pressure within the jar is reduced, and the atmospheric air moves in through the glass tubing and trachea, to fully distend the

lungs; as soon as the hand is withdrawn, and the flexible rubber falls back, the lungs completely collapse.



BELL JAR

This illustrates admirably how the pressure of atmospheric air fills the lungs when the diaphragm descends, and how the lungs are emptied when the diaphragm rises. It

will be seen that the lungs are perfectly passive.

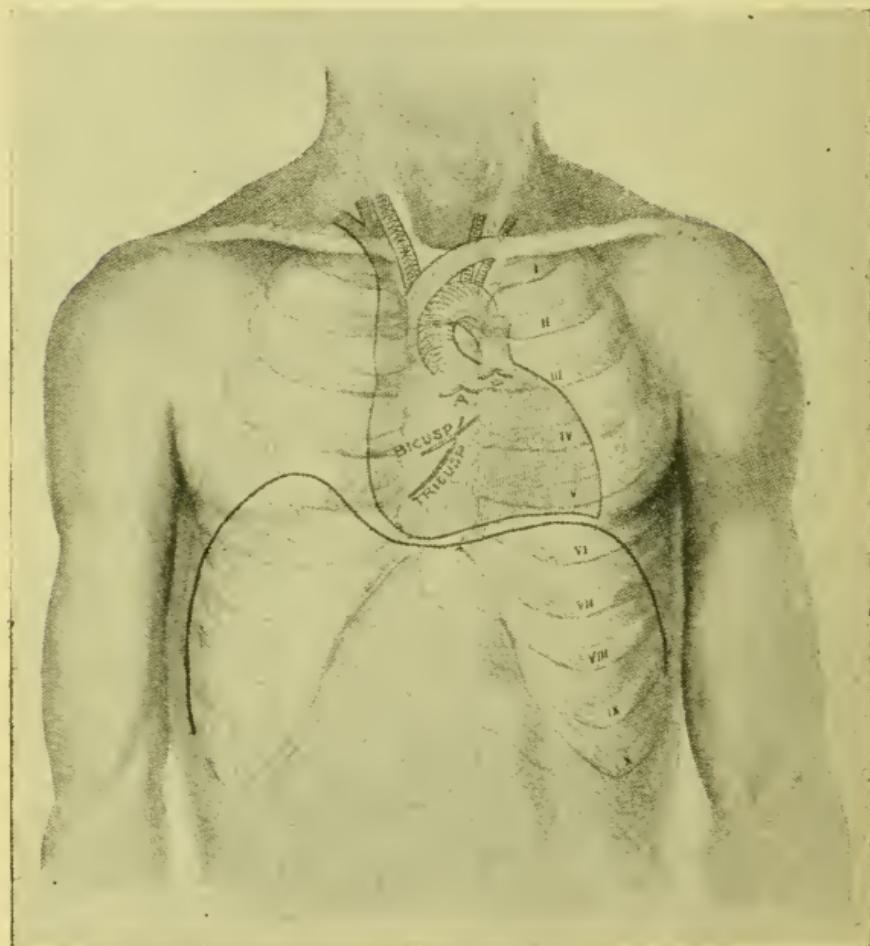
We have been granted permission to insert five illustrations from Dr. G. G. Davis's "Applied Anatomy," published by Lippincott, Philadelphia. Without some definite knowledge of the anatomy and mechanics of normal breathing, we cannot well understand the mechanics of artificial respiration. It is unfortunate how little attention many men—well versed in dynamos, motors, turbines—have given to the human engine.

Fig. No. 1. The line of the diaphragm is projected on the chest, and the heart and chief blood vessels are exhibited in relation to the ribs and cavity of the chest. It is well to remember that the diaphragm is a muscle; it is a voluntary muscle like the muscles of our arms, in that we can somewhat control our breathing; but in the main it is an involuntary muscle, like the muscle of the heart. The diaphragm is just as necessary to our breathing as the heart is to our circulation; the cessation of the action of either causes death.

In normal breathing the diaphragm descends, thus producing a partial vacuum in the lungs, and the air rushes in through our nostrils and mouth to inflate and dis-

tend our lungs. This filling of the lungs is called inspiration.

When the lungs are filled, the diaphragm



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FIG. 1.

again rises; this compresses the lungs and the air is forced out. This emptying of the lungs is called expiration.

The chief respiratory muscle is thus seen to be the diaphragm; it rises and falls from the minute of our birth to the hour of our death, like the piston of an engine in its cylinder.

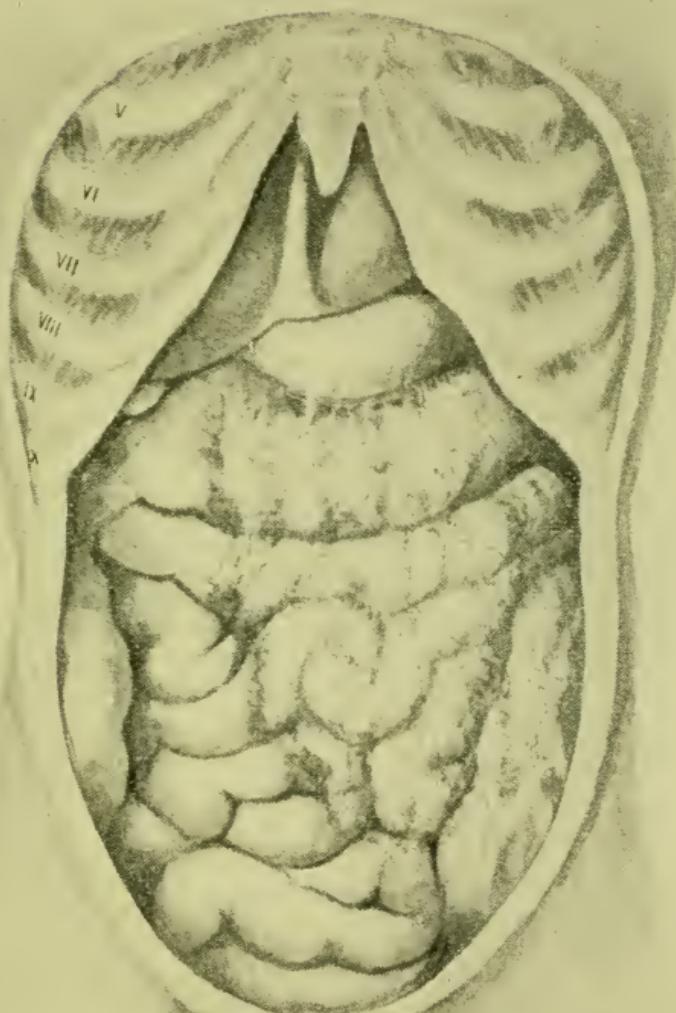
It will be observed that the diaphragm is a muscular partition and that it separates the chest, which contains the heart and lungs, from the abdomen, which contains the stomach, spleen, liver, kidneys, intestines, and other organs. The diaphragm is arched, with its convexity above and its concavity below; this concavity is filled with the stomach, spleen, liver and kidneys. It is also to be observed that ten of the twelve pairs of ribs are connected with the sternum (or breast bone); seven pairs by means of bone, and three pairs by means of costal cartilages. On the left side the diaphragm rises to the height of the sixth rib, and the stomach is separated from the heart only by the thickness of the diaphragm; on the right side the diaphragm rises to the height of the fifth rib, and separates the lungs from the liver.

The lowest ribs, the eleventh and twelfth, are also projected in this picture; they are seen to arise from the eleventh and twelfth thoracic vertebræ. They lie embedded in the muscles, and are in no wise attached to the sternum.

Fig. No. 2. The ribs, it will be observed, give protection to the organs most easily injured. Very little of the stomach is exposed to blows over the abdomen. The stomach is protected by the lower ribs on the left side; the liver by the ribs on the right side. This illustration with the interior abdominal wall removed shows the relation of the large and small intestines. The stomach is a muscular organ with a normal capacity of three pints.

Fig. No. 3. This illustration shows the bed of the stomach; the stomach has been removed. The spleen, the suprarenal and the left kidney are exposed, lying behind the stomach. The liver, it will be observed, is an organ of huge size and tremendous importance.

Fig. No. 4. This is an anterior-posterior section of a frozen body. It shows the diaphragm at the level of the fourth rib. Lung and heart are sectioned, above the diaphragm; and below the diaphragm are seen the stomach, transverse colon, spleen, pancreas, kidney and small intestines. This is a picture worth memorizing, as it bears directly on the problem of elevating the diaphragm in the act of giving artificial respiration. It is readily perceived that anything that will increase the pressure within the abdomen (intra-

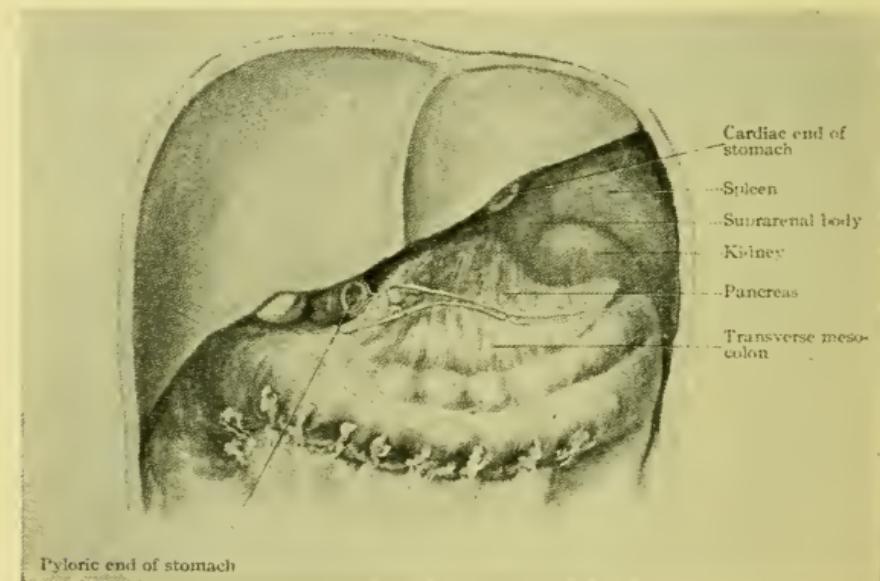


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FIG. 2.

abdominal pressure) will elevate the dia-phragm.

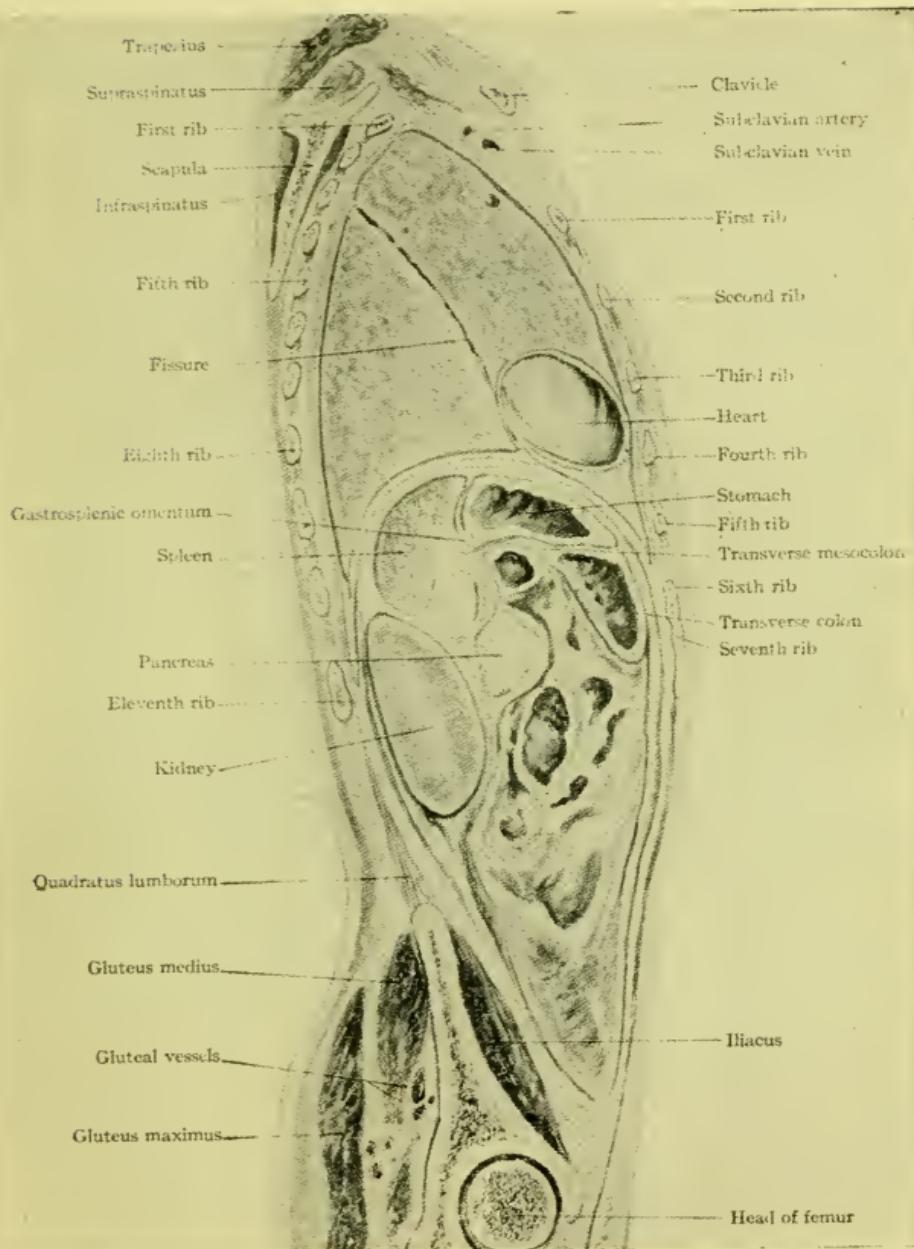
Fig. No. 5. This shows the spleen under the tenth rib; the kidneys under the eleventh and twelfth. As before stated *ten of the twelve* pairs of the ribs that arise from the vertebræ



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FIG. 3.

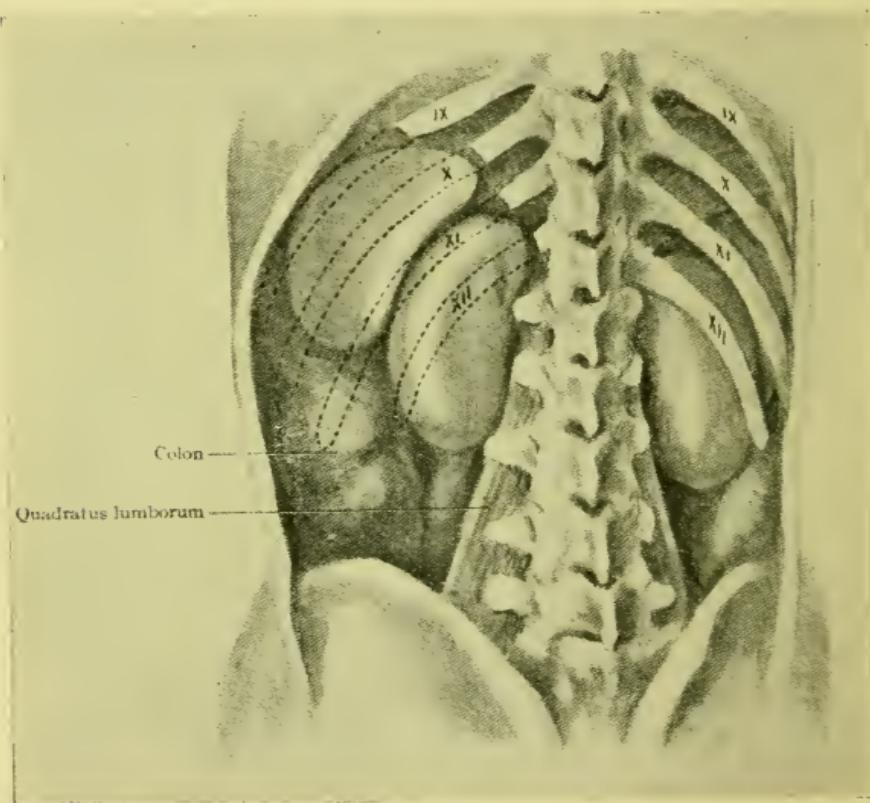
are attached to the sternum, completing a firm but elastic bony cage, known as the chest, or thorax. Two pairs are unattached in front, but end in the muscles; these are known as the floating ribs. These lower ribs (the eleventh and twelfth) are utilized in giving artificial respiration by the Prone Pressure method. To find these ribs and



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FIG. 4.

make pressure on their free ends is the prime consideration. Prone Pressure is the worst imaginable method of artificial respiration, if pressure is made too high or too low, and



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FIG. 5.

not made on the free ends of these floating ribs.

We press on the ends of the floating ribs like on a pump handle; the nearer their ends we make pressure the more leverage we have.

When they are pressed upon vertically and the pressure suddenly removed, their elasticity causes them to rebound to their natural position.

By compressing these floating ribs, thus shoving the abdomen against the ground, we shove forward the kidneys, and raise the pressure in the abdomen; this increased intra-abdominal pressure shoves the stomach, spleen and liver upward against the diaphragm. As the diaphragm is elevated it compresses and empties the lungs. Now relax the pressure of the hands—it is better to remove the hands entirely—and the resiliency of the parts causes the ribs to spring back into position, and enables the organs that have been displaced by the pressure to fall back into their normal relations. As these displaced organs flop back into their normal positions, the diaphragm descends, and there is a partial vacuum in the lungs; the air rushes in as in normal breathing, until the pressure within the lungs about equals atmospheric pressure.

In other words, the efficiency of the method is seen to depend on the elasticity of the thorax and abdomen and the tendency of the lungs to assume their normal shape and volume after being altered by any compressing force.

In every essential respect this artificial mode of respiration resembles natural breathing, except that a man gets more ventilation of his lungs than in ordinary breathing.

THE METHOD

There are four facts in the Prone Pressure (or Schaefer) method that require emphasis:

(I) The position of the patient

The man is laid on his stomach, face turned to one side, so that the mouth and nose do not touch the ground. The subject's arms are extended from his body above his head. (See illustration.)

This position causes the tongue to fall forward of its own weight, and so prevents its falling back into the air passages. This fact makes it possible for one man, alone and unassisted, to save the life of a comrade in electric shock, or other condition requiring artificial respiration.

Turning the head to one side prevents the face coming in contact with water or mud during the operation. There is no time for removal of the body to another place—the resuscitation must be begun the instant the body is recovered from the circuit, or other



RESUSCITATION.

source of trouble, even though other places in the neighborhood may be cleaner.

This position of the subject facilitates the removal of any foreign body from the mouth—tobacco, chewing gum, false teeth; and favors the removal of mucus, blood, vomitus, serum—any liquid that may be in the mouth or obstructing the air passages.

(II) Posture of the operator

The operator kneels, straddling one or both of the patient's thighs, or kneels by either side of the thighs, facing the patient's head.

The operator feels with both hands for the bony landmarks of the patient—the prominent bones of the pelvis, the muscles of the small of the back, and the floating ribs. With the lowest ribs located, the operator places his spread hands, with the thumb nearly parallel to fingers, so that the little finger curls over the end of the twelfth rib. With the hands on the pelvic bones we defeat the object of our work; hence, the bones of the pelvis are first located in order to avoid them. The lower margin of the hand must be free from the pelvis, and resting on the lowest rib.

We can more easily locate the ribs and avoid the pelvis by operating on the bare back of the victim. Hence, the shirt and other cloth-

ing should be torn off, and the operator's hands should be on the bare back of the patient.

The nearer the ends of the ribs the heels of the hands can be placed without sliding off, the better. The hands are thus far removed from the spine, and the fingers are nearly out of sight. If the thumbs are rotated outward somewhat, and held parallel to the fingers, it assists in holding the arms straight.

The fingers help some, but the chief pressure is exerted by the heels (thenar and hypothenar eminences) of the hands, with the weight coming straight from the shoulders. It is a waste of energy to bend the arms at the elbow and shove in from the sides, though a very muscular operator may succeed by this plan. Shoving the hands in at the sides in addition to the vertical pressure is less beneficial than the vertical pressure alone, besides being more fatiguing to the operator, because our backs are stronger than our arm muscles.

With the heels of the hands on the ends of the floating ribs, as described, the maximum leverage is exerted, and there is a corresponding reduction in the muscular exertion required on the part of the operator.

(III) The mode of operation

The operator's arms are held straight, and his weight is brought from his shoulders by bringing his body and shoulders forward. This weight is gradually increased until at the end of the three seconds of vertical pressure upon the lower ribs of the patient, the force is felt to be heavy enough to compress the parts; then the weight is suddenly removed; if there is danger of not returning the hands to the right position again, merely the pressure may be entirely remitted, but it is usually better to remove the hands entirely.

If the operator is a mere boy, and the victim an overweight adult, the boy can utilize over 80 per cent of his weight by raising his knees from the ground, and supporting himself entirely on his toes and the heels of his hands—the latter properly placed on the ends of the floating ribs of the patient. In this manner a mere boy, if he knows how to locate his hands, can work as effectively as a grown man.

A light feather, or a piece of absorbent cotton drawn out thin and held near the nose by someone, will indicate by its movements whether or not there is a current of air going and coming, with each forced expiration and

spontaneous inspiration. With such assurance as this, the operator possesses increased hopes of ultimate success. Should the elasticity of the ribs and the resiliency of the other organs fail, and there be no signs of returning animation, what then? With no discernible air coming and going, there may still be hope, keep busy. But, if a pulmotor has by this time arrived, if it is in good working condition, it can be given a trial.

As to the dangers incident to this mode of operation, questions are being continually addressed to the author. Some very strong and very heavy men doubtless do exert more pressure on the floating ribs than is necessary for the proper administration of artificial respiration. If the operator is at all observant, he can feel the ribs give way, and remit pressure; and he can see them spring up into place, whereupon he can again apply the pressure.

The author has never seen a case of fracture of the ribs, or any damage to internal organs arise from the Prone Pressure method. On the contrary, it is the method par excellence for restoring the victims of foot ball, basket ball, running (any form of knockout or excessive fatigue), as well as the foregoing enumerated causes of paralysis (inhibition) of the diaphragm. With the patient flat on

his stomach, the saliva will run from his mouth and his tongue will fall forward, and the rubbing, slapping and other methods of bringing him to will more quickly succeed; even in those cases where the breathing has not been arrested, pressure on the floating ribs is helpful in restoring him to condition.

Passive movements applied to the floating ribs, without resistance on the part of the person who receives the treatment, improve the wind as many athletes know. This treatment loosens up the movable organs above and below the diaphragm, and by giving freedom of movement to the diaphragm, imparts tone and vigor to the whole system. Such exercise conveys a feeling of exhilaration, when the operator works rhythmically and when the subject passively submits to it. It should be made a part of every gymnastic course where it has not already been adopted, especially in college and Y. M. C. A. gymsnasiums, and in boy scout organizations. We are informed that it is employed in the United States army as part of the setting-up exercises.

In brief, such passive pressure on the floating ribs improves the health, and can do no damage to a healthy man. There is an occasional individual who knows himself to be a living pathological museum; with extensive pleural adhesions, pericardial adhesions, can-

cer of the liver or stomach, advanced pulmonary tuberculosis, or the like—with such complications, what method of resuscitation could be recommended? Such persons, fortunately, are not in the active pursuits of life, so that the employment of the Prone Pressure method, where required, is not likely to affect them; nor do such persons voluntarily elect this mode of physical culture.

Let us remember that in a normal man the organs above the diaphragm and those beneath it are freely movable with each respiration. The range of movement of the heart between forced inspiration and forced expiration exceeds three inches. The author saw this demonstrated by X-ray photographs of the heart in 1906 in the Berlin Charité Hospital; it is well known to every radiographer. As this migration of the diaphragm and associated organs occurs with every breath we take, it is to be regarded as normal and healthful; and so is the proper administration of the Prone Pressure method of artificial respiration, in assisting nature, whether for purposes of resuscitation or purely for physical culture.

(IV) Rate per minute and duration of operation

The natural rate of breathing is twelve to fifteen times per minute. The rate of operation should not exceed this; the lungs must be thoroughly emptied by three seconds of pressure, then their refilling takes care of itself. Pressure and release of pressure—one complete respiration—occupies about five seconds. If the operator is alone he can be guided in each act by his own deep, regular respiration, or by counting, or by his watch lying by his side; if comrades are present he can be advised by them.

The duration of the efforts at artificial respiration should ordinarily exceed an hour; indefinitely longer if there are any evidences of returning animation, by way of breathing, speaking, or movements. There are liable to be evidences of life within twenty-five minutes in patients who will recover from electric shock, but where there is doubt the victim should have the benefit of the doubt. In drowning, especially, recoveries are on record after two hours or more of unconsciousness; hence, this method, being easy of operation, is more liable to be persisted in. The phy-

sician on his arrival can determine if there is any heart action; the pulse at the wrist may stop, and the heart still be beating—a condition calling for continuous rhythmic efforts at resuscitation, combined with medication.

In this connection it must be remembered that a physician is not necessarily infallible; two cases have been brought to my attention within the past year where physicians examined victims of electric shock, and reported them dead, yet both men were revived by artificial respiration. One was revived within an hour, the other in two and one-half hours. The friends of these men had better muscle, and more courage, than the physicians who pronounced the doleful verdict; and courage plus muscle won out. When a man's comrades know the possibilities of the Prone Pressure method, and have confidence in their ability to apply it, you may rely upon it that the victim of accidental electrocution will not perish unassisted before the eyes of his friends.

Just a word in relation to the fibrillating heart. The electric current arrests the action of the heart before it stops the respiration, by paralyzing the diaphragm, according to the best observers in physiological laboratories. Suppose the heart is contracting irregularly

in groups of muscle fibres, and is not propelling its two ounces of blood with each ventricular contraction. That is what you must often combat—both heart failure and respiratory failure.

By the Prone Pressure method, the stomach, spleen and liver are hurled up against the heart once every five seconds—only the thickness of the diaphragm separates the heart from the organs that are thrown against it; artificial respiration by this method is effectual massage of the heart. And furthermore, the great abdominal vessels are much compressed, and blood is likewise forced from the liver into the heart; when the heart is filled in this manner, it tends to recover its normal contractions.

It is a crime to stop and theorize about "the fibrillating heart," when a man is down and out and is in need of intelligent efforts at resuscitation; then and all the time the fibrillating heart is a good thing to forget.

The man on the firing line must assist his comrade with unfaltering courage, for success is the rule in these cases, if the artificial respiration be begun at once and continued without any interruption. Please remember that electric shock, and gas, and drowning, and other conditions that paralyze the diaphragm, are

as a rule not so dangerous to life as the ignorance and incompetence of the man's comrades, in the way of rendering immediate assistance.

SUPPLEMENTAL ASSISTANCE

When there is but one person with the victim, the artificial respiration will occupy his whole time. It is the chief thing to be done. It alone will usually save life.

If a second person is present, his first thought should be the man's mouth—he must be sure it contains no tobacco, gum, false teeth, blood, mucus—it can be cleaned in a moment with a stroke of the finger. He can make sure that the tongue is forward, and that no tight collar unduly constricts the neck. If the muscles are spastic and the jaws tightly closed, this second man can assist the first, and both can exert their whole weight in overcoming the rigidity of the abdominal muscles. Even if the jaws are set and rigid, Prone Pressure will succeed, with the patient breathing through his nose.

The second man can then direct his attention to providing some form of ammonia for the patient to inhale.

An unconscious patient must not be given any liquids whatever by the mouth; the liquids under these conditions will reach the lungs rather than the stomach. But medicines may be administered by (a) inhalation and (b) by hypodermics.

Aromatic spirits of ammonia may be poured on a handkerchief and held continuously within three inches of the face and nose; if other ammonia preparations are used, they should be diluted or held further away. Try it on your own nose first. We should not take an unfair advantage of an unconscious patient, by using aqua ammonia in a manner dangerous to his mucous membranes. If no ammonia is available, then spirits of camphor or spirits of menthol may be similarly employed.

In cases of asphyxiation, the patient must be removed to a better atmosphere; a tank of oxygen is then a valuable accessory to artificial respiration, though in electric shock and other conditions requiring artificial respiration, ordinary atmosphere, and some preparation of ammonia, if available, is all that is required.

The doctor should be summoned at once. On his arrival he can support the action of the heart, and the respiration, by the hypodermic administration of such drugs as strychn-

nine, atropin, digitalin, camphor in oil, adrenalin, etc., in appropriate dosage, as conditions require.

The most efficient service a crowd can render is to stand back, and allow the patient to have air, and not interfere with the person or persons endeavoring to resuscitate him.

It is to be distinctly understood that valuable as drugs are, the prime consideration is continuous, rhythmic, uninterrupted, artificial respiration. Other things are supplemental, more or less incidental, such as rubbing the hands, paddling the buttocks or feet, pulling on the tongue, stretching the sphincter muscle of the anus, sprinkling cold water on the face, or procuring blankets and hot-water bottles, if the patient is exposed to undue cold.

The patient may be apparently recovered and able to breathe, but lapses again into unconsciousness, and the breathing discontinues. In that event, we must resume the artificial respiration as often as is necessary to restore the patient. We dare not stop the Prone Pressure method, nor permit the patient to stand up, until his breathing has become regular.

There should be no delay in the attempt to revive the patient, such as is incident to

removing the victim in an ambulance; he must be revived first, or the artificial respiration must be carried on in the ambulance en route to the hospital.

MECHANICAL RESUSCITATION

Electrical excitation is a recognized method in restoring life in an apparently dead body. Experiments of this character have been carried on for years in every physiological laboratory in this country and in Europe. Dogs are usually chosen. The dogs are chloroformed until dead, or until respiration has ceased, and all heart action has discontinued. They are then revived by electrical excitation. Animals apparently dead four or five minutes are resuscitated, and when once restored to life the animal lives and shows no after effects. "Electrocuted dogs are resuscitated less readily than are chloroformed dogs."*

The electrical apparatus devised by this author, and by others, is a valuable contribution to science, but has not superseded the reliable manual methods. Why rely on the

* Dr. L. G. Rubinovitch, in The Journal of the American Medical Association, Vol. LXI, No. 8, article on "Electrical Resuscitation after Heart Failure under Chloroform or Electrocution."

arrival of certain equipment, when you know that a patient will pass into eternity unless instantly assisted?

In an address before the Berlin Congress of 1890, Dr. H. C. Wood of the University of Pennsylvania called attention to the value of FORCED ARTIFICIAL RESPIRATION.* He declared that he had repeatedly taken dogs in which both respiratory and heart movements had been absolutely arrested by chloroform or by ether, and had restored them to life by pumping air in and out of the lungs. All the apparatus that Dr. Wood believed necessary was a pair of bellows of proper size, a few feet of India-rubber tubing, a face mask, and two sizes of intubation-tubes† (in case the face mask should not suffice); also a valve arrangement, so that the operator can allow the escape of any excess of air thrown by the bellows.

He further called attention to the fact that Dr. Fell of Buffalo had demonstrated

* American Text-Book of Surgery, 1903.

† It is probable that the Pulmotor would be a more reliable device if its makers likewise recognized the defects of a mask; air may enter the stomach as well as the lungs, and intubation is then the remedy. Pressure over the trachea, as recommended in Pulmotor literature, may exclude air from the lungs as well as the stomach.

the extraordinary efficacy in man of forced artificial respiration, in severe morphine poisoning, so that the methods of the physiological laboratory must be considered applicable to human beings. Dr. Fell used a bellows apparatus, a receiving chamber for warming the air, and a valve for control of air pressure, opened and closed by a movement of the finger.

The precaution advanced is this: "Due care must be exercised that no force sufficient to rupture the air-vesicles is employed."

In natural breathing, as previously described and illustrated, the diaphragm rises and compresses the lungs, and the air is forced out of them; by the Prone Pressure method, the organs below are made to shove the diaphragm upward, and the lungs are thus compressed, the air being forced out. In both natural breathing and the Prone Pressure method the diaphragm descends of itself; in the former spontaneously, while in the latter the elasticity and resiliency of the ribs and displaced organs make the descent of the diaphragm certain, as soon as the compressing force is removed from the ends of the floating ribs. Then the lungs are a partial vacuum—there is negative pressure—and atmospheric air rushes in through the trachea to fill and inflate the lungs. The lungs are passive;

there is thus no possibility of damage to the air-vesicles, either in normal breathing or in artificial respiration by the Prone Pressure method.

But contrast this with any bellows type of apparatus; unless enough pressure is exerted to distend the lungs and shove down the diaphragm, it is not very efficient, so that at best this type of apparatus may be regarded as potentially dangerous, and accepted as a last resort only where tissue resiliency is much impaired.

It may be remarked that of the various mechanical devices of the bellows type available for giving artificial respiration, the Draeger Pulmotor is being most exploited, and is highly recommended by the Bureau of Mines in the Pittsburgh district.

We are informed that Pittsburgh, in endeavoring to apply its slogan, "Pittsburgh Promotes Progress," has placed a pulmotor on every patrol wagon. Other cities are doing likewise. Policemen and firemen of all cities should be thoroughly trained in resuscitation by the Prone Pressure method. Such instruction would certainly contribute more to the general welfare, in the conservation of life, than the installation of any type whatsoever of mechanical resuscitation device on every ambulance and patrol wagon.

The author has in his possession a letter, the writer of which talked with the superintendent in charge of the Water Side Stations No. 1 and No. 2, of the New York Edison Company. He has used this resuscitation device with great success, "having resuscitated five out of the last six persons on whom it was tried; the one person on whom the device failed had been dead so long, that he was turning black. One woman who had been apparently dead for three hours was revived after the machine had been in operation almost two and a half hours."

We believe that this is an extravagant claim; that no manual method, and no mechanical device, can be relied on to resurrect the dead. After so long an interval has elapsed, unless the work of resuscitation has been continuously performed, life is doubtless extinct. After all, there is nothing so dependable as the hands of a man's friends. Mechanical devices may be too remote, or when procured may be out of order, and not bring results.

In cases of asphyxiation by poisonous gases, the Pulmotor, since it employs oxygen, and exerts suction as well as pressure, is serviceable; it has a field where fractured ribs and ruptured viscera (as in falls from a pole), or extensive body burns, complicate the employ-

ment of the Prone Pressure method. But even with these complications, should there be no Pulmotor instantly available, it is better to employ the Prone Pressure method, and ignore the injuries for the time being; the infliction of pain, in this instance, may more quickly restore the respiration.

It is suggested, by the way, that the generation of ozone in the room will improve the prospects of recovery, and is perhaps superior to a tank of oxygen.

It is questionable if the various mechanical devices now on the market, or which may hereafter be invented, can ever "wholly supersede manual methods of resuscitation."

"Whatever in the way of equipment may some day merit general adoption, we know that no reliance can be placed on any outfit that cannot be carried with every electrical workman, and that is not instantly available. We know that success in artificial respiration is attained by the Prone Pressure method, and by other manual methods. Indeed, ignorance of such a method of resuscitating a comrade is criminal negligence on the part of any man of normal intelligence and conscience."*

* Extract from "Electrical Injuries," Chas. A. Lauffer, M.D., John Wiley & Sons, New York.

PROF. SCHAEFER ON THE PRONE PRESSURE METHOD

The most appropriate conclusion to this paper, I believe, would be to insert some extracts from a paper on the subject by Prof. E. A. Schaefer, read in Chicago, 1908, before the section on surgery of the National Convention of the American Medical Association.*

"In 1890 the Royal Medical and Chirurgical Society of London appointed a committee to investigate these and other methods of performing artificial respiration, and of this committee I was made chairman. A large number of experiments were performed on the cadaver, which were mostly futile by reason of the difficulties presented by post mortem rigidity. Subsequently transferring the work to Edinburgh, we made similar investigations

* Extracts from "Artificial Respiration in its Physiological Aspects," by E. A. Schaefer, F.R.S., Professor of Physiology in the University of Edinburgh, Edinburgh; Journal of the American Medical Association, Vol. LI, No. 10.

on the living passive subject, and also investigated in dogs the physiologic phenomena presented in drowning and the best means of producing recovery in these animals by artificial respiration. In this research I received the aid of Dr. P. T. Herring of the physiology department of the University of Edinburgh, and of my other assistants there.

"As the outcome of this work we concluded that, for the performance of artificial respiration without the aid of bellows or other apparatus, a pressure method is best, and that such a method is more efficient with the patient in the prone position and with the pressure applied vertically over the lowest ribs. In this way not only is the thorax compressed, but also the abdomen, against the ground. The pressure against the abdomen forces the viscera against the diaphragm, which is thereby itself moved upward, driving air out of the lungs. On relaxing the pressure the elasticity of the parts causes them to resume their former shape and volume, and the air is drawn in through the glottis. The pressure is exerted gradually and slowly, occupying some three seconds; it is then removed during two seconds and again applied; and so on some twelve times a minute. To this method I have given the name of 'the Prone Pressure method.'

"In performing it the operator kneels or squats by the side of or across the patient, places his hands over the lowest ribs and swings his body forward and backward so as to allow his weight to fall vertically on the wrists and to be removed; in this way hardly any muscular exertion is required. The efficiency of a pressure method of artificial respiration depends on the fact that after an ordinary expiration the thorax still contains some 1500 c.c. of air which can be expelled by a forced expiratory effort; this is the reserve or supplementary air of Hutchinson. It is easy to conceive that of this reserve air, one-third, i.e., 500 c.c., can be forced out from the chest by pressure, and, as a matter of fact, considerably more than that amount can be expelled when the pressure is applied in the prone position as just described. By repeating the movements—pressure and relaxation—twelve times a minute, we easily get an air exchange of 6000 c.c., which is more than the average normal amount."

CLINICAL MANIFESTATIONS OF ILLUMINATING GAS POISONING *

“ During the last ten years I have had opportunity to observe 1000 cases of illuminating gas poisoning in several cities through connection with the medical staffs of several of the large gas companies of the United States. . . . During this time some of the men have been overcome by gas fifteen or twenty times, and this has given the opportunity to study the so-called cases of chronic gas poisoning. . . . In illuminating gas, as furnished by the better companies, the carbon monoxide present is the poisonous principle; the other constituents used to increase the candle-power are non-toxic. . . .

“ For purposes of convenience, the various symptoms of illuminating-gas poisoning have been divided into three stages: FIRST STAGE continues until the patient loses consciousness.

* Extracted and condensed from the American Journal of the Medical Sciences, October, 1912, Vol. CXLIV, p. 577, by permission of the author, Robert S. McCombs, M.D., of Philadelphia. Read by invitation before the College of Physicians of Philadelphia, May 1, 1912.

. . . SECOND STAGE begins with syncope and ends with apnoea. . . . In the THIRD STAGE the patient is comatose and respirations have ceased. . . .

"SEQUELS. Symptoms that persist after the blood is free of carbon monoxide are referable principally to the nervous system. . . . All of the sequels mentioned have eventually cleared up entirely within a period of six months or less. They constitute less than 2 per cent of all the cases and are almost entirely confined to advanced second-stage cases and third-stage cases. Any method which tends to shorten the period during which the blood is impaired will tend to prevent the late symptoms due to tissue injury. There have been individuals poisoned by illuminating gas who have been suffering at the time from chronic organic involvements of almost every description, many pregnant women are included in these statistics, also patients with tuberculosis and several who were in the midst of typhoid fever. None suffered any permanent bad effects and no miscarriages have occurred; the children when born have been normal. Sequels are more likely to occur in those of advanced years.

"PROPHYLAXIS. It is not the purpose of this paper to belittle the poisonous nature of

carbon monoxide. The fact remains, however, that deaths result in nearly all cases from preventable causes.

" It should be noted in comparing this statement with various reports of accidental deaths from carbon monoxide poisoning, which amounted to 624 in twenty-three years in the State of Massachusetts, as reported by Sedgwick and Schneider, that the cases may be divided very sharply into two classes of accidental poisoning:

" 1. Those in which the accident consists in a break in a pipe in a room; failure to close the gas jet (the usual method); or by other accidental causes of a similar nature, all of which produce contamination of the atmosphere with a high degree of carbon monoxide in a short time.

" 2. Accidental cases due to street leaks; due to cracking of the mains by frost, the unequal contraction of frozen ground will break the pipes. At times the escaping gas cannot filter through the superimposed earth, but works its way through water and rat-holes or along pipes into the cellars. The odor of gas is always noticeable. In Philadelphia there has been only one instance where death has resulted from the second class of cases and this was preventable.

" Suicidal cases make up approximately

one-half of all the fatalities here and in Massachusetts.

"The majority of deaths were preventable if the individuals had slept with open windows, had paid attention to leaking gas and had reported it immediately, and of course, if they had properly closed the gas stop.

"**TREATMENT.** The essential of treatment consists in the inhalation of oxygen, under pressure whenever possible. The object of all plans of treatment is to supply oxygen in sufficient quantities to displace the carbon monoxide in combination with the hemoglobin.

"Oxygen inhalations are indicated in all stages.

"In first-stage cases fresh air combined with mild stimulation, such as aromatic spirits of ammonia, should be administered. In this stage the nausea, vomiting, and headache are the most troublesome symptoms. The greater part of the gastric symptoms will be relieved by some effervescing salt, the patient feeling much better after eructating or vomiting. It is due to this relief from nausea and gastric distention that a peculiar remedy for gas poisoning obtained its reputation as an antidote among men working in gas; it is an effervescing birch beer, called 'Weiss Beer.' Effervescing phosphate of soda has been substituted. There is no true anti-

dote for gas poisoning other than oxygen. The headache usually persists for twenty-four or forty-eight hours and may be relieved by any of the drugs used for this condition. Violent exertion is to be avoided, as collapse is a danger; men who have become aggressively delirious have collapsed.

"Second stage. The patient is unconscious but breathing. It may be necessary if the respirations are not stertorous to assist the respiratory action. The Howard method (compression of the lower part of the chest in rhythm with expiration) has been found efficient. Oxygen must be administered preferably under pressure. Haldane placed animals (mice) in oxygen under a pressure of two atmospheres, so that simple solution of oxygen in the blood serum was obtained sufficient to support life independently of the hemoglobin. Enough carbon monoxide was present to completely saturate their hemoglobin. Under these conditions the animals remained normal as to symptoms, showing that the carbon monoxide had no direct toxic action. When the pressure was removed and the mice put out in the air they died with symptoms of asphyxia.

"Various mechanical devices for administering artificial respiration and supplying oxygen have been tried, but until lately all

were unsatisfactory. At present the 'pulmotor' is being used. This machine automatically adjusts itself to the individual capacity of the lungs, without danger of rupture, and maintains a mixture of oxygen and air (60 per cent oxygen) under a constant pressure of five atmospheres. It maintains artificial respiration perfectly. Reports from all over the country relative to its efficiency have been received. Whenever possible it should be used. Undoubtedly the prompt suction by the pulmotor, of the carbon monoxide present in the residual air and that which is being constantly eliminated from the blood, materially aids resuscitation.

"Medicinally the patient should be freely given hypodermics of stimulants such as camphor, caffeine, digitalis, and strychnine. Heat should be applied when indicated and as there are several cases in which the persons have collapsed when taken out into cold air, it is always better to start treatment in a warm room. A very important adjunct to this plan of treatment is the massaging of the muscles after aërating the lungs; the increase in the hemoglobin in the general circulation accomplished by it often promptly restores the normal oxygen balance.

"The above methods are usually followed by prompt recovery. If they are not success-

ful, venesection with the introduction of normal salt solution should be employed. Two cases have come under my personal observation at the Philadelphia Polyclinic Hospital in which this method was followed by rapid and complete recovery, although there was some mental confusion in both cases for some time. . . . Should the 'pulmotor' fail, the best method is the direct transfusion of blood as practiced by Crile and his followers. His experiments, reported in the Amer. Jour. Med. Sci., led him to conclude that blood transfusion seems to be of greater therapeutic worth than the other measures considered. It has been used in 2 cases in Philadelphia, both of which made a prompt recovery after other methods had failed. The introduction of fresh hemoglobin which will combine with oxygen and which will not be contaminated by the carbon monoxide already held in a combination with the patient's hemoglobin is a sure way of restoring the normal oxygen balance. Transfusion should be done immediately if the patient is in the advanced second or in the third stage and fails to respond to the ordinary treatment. The only objection to this plan of treatment, according to Dorrence, is the fact that about 25 per cent of transfusion operations are failures unless undertaken by skilled surgeons.

" Third stage. The patient is not breathing and is unconscious. Artificial respiration, oxygen, stimulation and heat are imperative. Transfusion is indicated. The Schaefer or ' prone pressure,' method of artificial respiration is the best to use. The ' pulmotor' has maintained artificial respiration in this stage.

" Artificial respiration has been maintained for six hours with subsequent recovery of the patient.

" **PROGNOSIS.** If the above methods of treatment are carried out and the patient is not dead when discovered practically all cases should recover in forty-eight to seventy-two hours from the immediate effects of the gas, no matter how concentrated the carbon monoxide causing the poisoning. The great difficulty in treatment has been the failure of both laity and physicians to realize that inhalation of oxygen under pressure combined with venesection or blood transfusion in severe poisoning will save practically all the cases.

" Of 39 cases reported by Edsall occurring at the Episcopal Hospital in Philadelphia, mostly suicidal in intention, 34 fully recovered and most of the fatalities were due to sequels.

" The possibility of sequels developing some time after the poisoning must be borne in

mind, but all such cases in my experience have cleared up within six months.

" Gilman Thompson considers it a bad sign if leukocytosis, which he says is usually present, be of a high degree.

" CHRONIC GAS POISONING. Examinations of the blood of men who are constantly in contact with carbon monoxide, and of some who have been repeatedly poisoned, have been made. The average count shows a polycythemia. This is in accord with the report of the investigating committee authorized by the Illinois Legislature and published in the Journal of the American Medical Association, also with the 2 cases reported by Reinhold.

" I could not find any muscular weakness in the men examined. Some of them had been employed in this line of work for twenty years and are now among the strongest and healthiest individuals I know. As a rule, they pay no more attention to first-stage gas poisoning than the average person would to a headache. The estimation of muscular weakness by comparison with men in other occupations is difficult to obtain and is unreliable at best.

" I have seen no accumulative action of carbon monoxide unless the polycythemia may be an evidence of it. Reported symp-

toms such as irregularity of the heart, slow pulse, anemia, lack of concentration, poor memory, cardiac dilatation, splenic enlargement, and pleural effusions have not been observed in the laboring class I have had under observation.*

"Evidently the increase in the red blood corpuscles, the polycythemia, is to compensate for the presence of small quantities of carbon monoxide so that the normal supply of oxygen to the tissues can be maintained."

* "I think illuminating gas is blamed for a large number of cases of serious chronic poisoning which are due to defective heating apparatus and to broken furnace pots."

COMMERCIAL DEVICES FOR ARTIFICIAL RESPIRATION

The Commission of the National Electric Light Association on Resuscitation from Electric Shock, through a member of the Commission, Mr. W. C. L. Eglin, of Philadelphia, presented a notable report at the Association's thirty-sixth convention, in Chicago, June, 1913. This report is embodied in the general volume of the National Electric Light Association's convention proceedings for that year. Certain extracts from this report are pertinent in this connection, as illuminating the problem of the best method of resuscitation.

In the pulmotor apparatus the respiratory changes are made automatically by the mechanism of the instrument; it provides for inspiration by oxygen pressure and for expiration by suction. This device was tried out; to a less extent experiments were conducted with the Dr. Brat apparatus, the lungmotor, and the salvator.

"The pulmotor, although it has lacked scientific, surgical and medical sponsors, has received wide publicity through the daily press."

Pages 333-335 of this report are devoted to the investigation of alleged successful results, where the pulmотор has been employed.

"Natural respiration had not stopped," in some of the reported cases, consequently, "the credit of restoration does not belong to the instrument.

"In one case most favorable to the efficiency of the pulmотор, . . . *the support of life by manual respiration for over half an hour is rather in favor of that method.*

"Although the cases reported above do not furnish convincing proof of the necessity or the exceptional value of the pulmотор, that instrument is probably capable of creditable performance, and doubtless has, in some instances, favored the restoration of normal breathing. Its present vogue, however, is not supported by a critical examination of the principles involved in its mechanism or of its effects when used for long periods. As stated above, no well-considered testimony to its action is to be found in medical literature, and in this country at least its loudest sponsors are the newspapers, which have spread the impression that the pulmотор is a perfect and most reliable resource when respiration is suspended.

"A high official of one of the most important electric companies in the country testified

to a member of the Committee: 'We have to buy these machines, even if they are no good, as an evidence of our good faith and our desire to do everything possible to safeguard the public and employees.'

EXPERIMENTS WITH COMMERCIAL DEVICES FOR ARTIFICIAL RESPIRATION

"The effects of the Dr. Brat apparatus and the pulmotor were studied by the subcommittee in experiments on anaesthetized and curarized animals. The animals were thus doubly prevented from making any response to the action of the apparatus, and were, therefore, in a condition analogous to extreme prostration. The Dr. Brat apparatus, obtained by courtesy of the Westfalia Engineering Co., was used in a few experiments only, but the results were in essential points similar to those secured with the pulmotor. One pulmotor used was loaned by the Pittsburgh station of the Government Bureau of Mines. On returning the machine, Mr. Paul, the mining engineer in charge of the station, stated that the machine was in the same good working condition when returned as it was when sent. Another pulmotor, loaned by the New Haven Gas Co., was also tested and gave confirmatory results. Experiments

were performed on dogs, cats and rabbits. The oxygen was supplied through specially constructed masks adapted to the individual animals. The efficiency of these masks was tested by other respiratory apparatus at hand in the laboratory. The tongue was kept well pulled out. In several experiments the trachea was connected by means of a lateral cannula with a water manometer. In some cases also the intrapleural pressure was measured, and in others the thorax was opened and the behavior and appearance of the lungs observed.

" Of eleven dogs only one small animal (under 4 kilos), completely curarized, could be kept alive by means of the automatically working pulmотор for as long as one hour. The animal remained in fairly good condition, had about thirty respirations per minute, and no air entered the stomach. In another dog the usual laboratory method of artificial respiration (inflation of the lungs) had to be substituted for two to three minutes every eight or ten minutes in order to keep the animal alive. The respiratory movements would go on with the pulmотор regularly for a while, and then they would begin to change from a slow to a rapid rhythm and the pulse would gradually become dangerously slow. In two other animals the pulmonary respiration would

continue regularly at one position of the head, but stop at the slightest change from that position. On other occasions changes in the respiration would occur without any visible cause. *In the majority of the animals respiration could not be kept up even for five minutes when left to the automatic activity of the apparatus.* The result was evidently better when the respiratory alternations of the machine were guided by hand, so as to have sixteen to twenty respiratory cycles per minute. But even under these circumstances the circulation could rarely be kept up in a normal state for longer than twelve or fifteen minutes.

"When the thorax was opened *the lungs were seen becoming gradually smaller and smaller.* In a young dog and a cat the unopened thorax was also observed getting smaller as soon as respiration was started by the pulmotor. An equilibrium was soon reached and the respiratory changes in the size of the thorax apparently took place then within the normal expiratory diameters. The respiratory changes in the tracheal manometer would often be only from a more to a less negative pressure, never positive. The changes in the tracheal pressure amounted often only to 30 or 40 millimeters of water. *When the thorax was opened, after the pulmotor had been used for a while, the lungs often presented an*

uneven appearance, small collapsed areas alternating with much dilated areas. After connecting with the ordinary laboratory respiratory apparatus this unevenness soon disappeared. When the pulmotor was connected directly with the tracheal tube, respiration was kept up in a more reliable way, especially in cats and rabbits. When regulating the respiration by hand air often entered the stomach. Pressure upon the trachea or larynx rather prevented the entrance of air into the lungs and increased its entrance into the stomach.

“These observations on animals indicate that there are two factors which interfere with the efficiency of the pulmotor as a reliable device for artificial respiration. The first is its automatic activity and the ease with which inspiration is turned into expiration. Inflation and deflation of a bag—the method used by agents to demonstrate the action of the pulmotor—is deceptive, because the bag, unlike the air passages of the body, offers no resistance until full. As soon as the inspiratory blast meets an obstacle in the air passages it is automatically cut off and turned into expiration, and thus frequently no efficient inspirations are performed. In lower animals, certainly, the blast often meets obstacles while passing from the pharynx into the alveoli, and the inspiratory

pressure of the automatically working pul-motor is in many cases insufficient to overcome them. When guided by hand the inspiratory pressure is permitted to increase; hence the greater efficiency under these circumstances.

"The second harmful factor brought out by these experiments is the *performance of expiration by suction*. In normal respiration expiration is accomplished by a power which does not suck, but drives the air out by the elasticity of the distended or compressed tissues, aided, sometimes, by muscular contraction. The finer bronchioles have no cartilages; when air is sucked out from the trachea and larger bronchi, the bronchioles are liable to close before the suction reaches the alveoli. Furthermore, when the air is actively sucked out, the walls of many of the bronchioles and alveoli are liable to collapse and stick together, so that the next inspiratory pressure, which is barely sufficient to overcome the elasticity of the lung, is not strong enough to overcome the resistance offered by the adherent surfaces. The successive additional respiratory changes may therefore take place largely in the bronchial tree and not sufficiently in the alveoli; that is, there may be a lessened exchange of gases while the movements of the thorax still simulate normal respiration. Hence, failure of the

circulation ensues with diminution of the size of the lungs and the thorax. This obstacle, however, need not remain permanent. After several attempts, an inspiration may finally succeed in driving air into all the isolated alveoli or into many groups of them; hence the occurrence of changes in the respiratory rhythm of some animals, and the uneven appearance of the surface of the lungs in others. On the other hand, in some one or other individual animal the passage into the larynx, the organization of the bronchial tree, etc., appear to be well adapted to the rhythm of the pulmator, which therefore may be capable of keeping up the respiration of such an animal even when it is completely curarized.

"Finally, observation shows that the entrance of air into and escape of air from the stomach may cause movements of the thorax which simulate respiration while actually no air enters or leaves the bronchial tree.

"Upon the basis of these observations the conclusion was reached that the automatic mechanism of the pulmator, while being an ingenious technical contrivance, instead of assuring artificial respiration, may interfere greatly with its efficiency, because it is liable to cut off inspiration prematurely. The management of the changes in the phases of

respiration when the pulmotor is worked by hand is more reliable. But when handled in this manner no practical difference exists between the pulmotor and the Dr. Brat apparatus, at least so far as the mechanism is concerned. In both machines, however, the expiration is accomplished by suction, which is again a serious defect. The sucking action of these devices might prove even dangerous if they were used continuously to keep up respiration for a long time. In connection with experiments on animals, which in most instances could be continued a relatively short time only, it is pertinent to recall the fact that the successes reported by the physicians connected with the Carnegie Steel Corporation were obtained in cases in which the pulmotor was used for a short period only.

"That both machines are heavy, expensive and waste a great deal of oxygen, with which they are not sufficiently provided, are minor points in their disfavor. The absence of careful analysis of the action of the pulmotor in clinical cases, *the ease with which it may fail to cause inflation of the lungs, the bad effects which occur if its sucking action in expiration is permitted to continue for a long period, are all important considerations which should be taken into account in judging the*

instrument. When they are taken into account the high credit given the machine in *popular opinion seems not to have a substantial foundation.*

"In view of the facts obtained by a study of the Dr. Brat apparatus and the pulmotor the members of the subcommittee agreed upon the following suggestions: In cases without any respiration the pulmotor should be used only when guided by hand and then not faster than twelve to fifteen complete respirations per minute; when left to run automatically it is liable to be inefficient and dangerously deceptive. Because of suction on the lungs neither the pulmotor nor the Dr. Brat apparatus should be used longer than for a few minutes (five to six) at a time, and, if there be no better contrivance, should be alternated with the Schaefer method combined with oxygen inhalation. In cases of slow and stertorous breathing, however, both machines can probably be used for a longer time with benefit and without danger."

RESUSCITATION BY MEANS OF THE PRONE PRESSURE METHOD

Various methods of restoring life in persons apparently dead have been practiced from time immemorial. The Sylvester-Laborde method of artificial respiration was largely in vogue until superseded by the Schaefer or Prone Pressure method. This method is easy to learn, and can be successfully employed by one man. "Prone Pressure" utilizes the organs below the diaphragm to elevate the diaphragm, thus emptying the lungs; it cannot lacerate lung tissue and is the best substitute for natural breathing yet devised. By spirometer methods for the accurate determination of the volume of air moved, the old Sylvester-Laborde method is reported to have an efficiency of 177 c.c. of air volume expired, against 520 c.c. of air expelled by the Schaefer method. Making pressure twelve times a minute by the prone pressure method gives us 6240 c.c. of air expired, and a like amount inspired, affording more volume of air per minute than in normal breathing. Numerous successful results attest

to its practicability; those who have had occasion to use the Prone Pressure method, believe in it.

THE DIAPHRAGM

The diaphragm is an arched muscular partition. Its convex surface is the floor of the chest; the chest contains the heart and lungs. Its concave surface is the roof of the abdomen; the abdomen contains the stomach, spleen, liver, kidneys, intestines, pancreas, etc.

The diaphragm rises and falls like a piston rod in its cylinder; when the diaphragm rises, the air in the lungs is expired, and when the diaphragm descends, atmospheric air rushes in through the nose and mouth to inflate the lungs. Filling the lungs is inspiration, emptying them is expiration.

The normal lungs are unattached to the chest walls; only their blood vessels and the bronchi give them support. When empty the lungs are partly collapsed, but when filled with air they are expanded to occupy the cavities designed for them.

The lungs are passive in respiration; using the lungs of a cat in the familiar bell-jar experiment, and employing a sheet of rubber dam to represent the diaphragm, it is self-evident that the natural mode of inflating and emptying the lungs is by the activity of the diaphragm.

THE PARALYZED DIAPHRAGM

The diaphragm begins its activity at birth, and its cessation means death. The diaphragm is as necessary to life as the heart; the continuous rhythmic contractions of both muscles are necessary to continued life.

A man can fast 40 days or more if water is plentifully supplied him; but if his diaphragm is paralyzed for three minutes, thus depriving him of air, he may perish. A man requires oxygen, of which the air contains 20 per cent, and he must eliminate carbon dioxide gas, the retention of which will itself paralyze his diaphragm.

From whatever cause his diaphragm is paralyzed, it is self-evident that if the man's life is to be saved, artificial respiration must be employed until his disturbed nerve-centres recover their normal functions, that is, until he is able to breathe for himself.

WHAT PARALYZES THE DIAPHRAGM

When the diaphragm is paralyzed, the man stops breathing, the heart action becomes feeble and irregular, and there is unconsciousness. This condition of suspended animation can arise from several causes:

1. *Electric Shock.* By its action on the

nervous system, the passage of an electric current may arrest the diaphragm.

II. *Asphyxiation.* There are 40 or more non-respirable gases, which, upon entering the lungs, paralyze the respiratory center in the brain (medulla); exclusion of air, as in a closed vault, or in drowning, produces asphyxia, due to the lack of oxygen and the retention of carbon dioxide. Certain drugs, as opium, in a similar manner arrest the action of the diaphragm. Chloroform and ether may act in this manner.

III. *Traumatic Shock.* A blow on the head, jaw, or neck, or over the solar plexus, will paralyze the diaphragm. A man who gets such a knock-out blow, must be made to breathe until his disturbed nerve centers recover their normal functions.

FORETHOUGHT

We live in an age of steam and electricity, chemical processes, machinery, and rapid transit. Many accidents now fatal are so due to the failure to resuscitate the victim; suspended animation requires instant relief, and any man who fails to qualify himself, and who does not know how to give artificial respiration when the emergency arises, is morally considered, guilty of manslaughter.

The time to prepare for such calamities is just now; it is as much your business to know how as it is that of a physician, and a doctor, like the policeman, is never available when such emergencies arise. Every second is an hour, when a man's diaphragm is paralyzed; and unless he is immediately assisted by means of artificial respiration, later efforts may prove futile.

Please remember that the victim of electric shock is seldom killed outright by electricity; he needs artificial respiration. And the same may be said of the victim of gas, water, steam, ammonia, etc., who requires assistance until normal breathing is restored.

RULES

The Prone Pressure method may be conveniently reduced to five rules, and described in brief under these headings:

The Position of the Patient

The patient is laid on his stomach, face turned to one side, so that the mouth and nose do not touch the ground.

The patient's arms are drawn away from his body, or extended above his head.

The patient's mouth is cleansed of mucus, blood, serum, tobacco, chewing gum, false

teeth, by a stroke of the finger. This prone position causes the tongue to fall forward of its own weight, as well as facilitates the removal of liquids from the mouth and air passages by gravity. It is this fact that makes it possible for one man, alone and unassisted, to save the life of a comrade in drowning, electric shock, or other condition requiring artificial respiration.

The Posture of the Operator

The operator kneels, straddling one or both of the patient's thighs, or kneels by either side of the thighs, facing the patient's head.

The operator's hands are placed on the outer ends of the patient's lowest ribs; the fingers curl around under the body, and are out of the sight of the operator. Care is observed to keep the hands away from the spine, and to avoid pressure on the pelvis.

The Mode of Operation

The operator's thumbs are rotated outwards, which assists him in holding his arms straight; he does not use his arm muscles, but his body weight is brought from his shoulders, by bringing his body and shoulders forward.

This weight is gradually increased (there

is no sudden thrust), until at the end of three seconds of vertical pressure upon the lowest ribs of the patient, the force exerted is felt to have compressed the parts, then the weight is suddenly removed.

When the pressure is thus exerted on the lowest ribs, the organs under the diaphragm (the liver, stomach, spleen, kidneys, etc.), drive up the diaphragm; when the hands are removed, or the pressure remitted, the displaced organs drop back to their normal relations.

When the diaphragm is thus forced to rise, the lungs are emptied. When it descends a partial vacuum exists, and the lungs are filled by atmospheric pressure. The lungs are thus passive, as in normal breathing. Hence, by the Prone Pressure method, there is no possibility of lacerating lung tissue, such as is liable to occur when mechanical apparatus of the bellows or "suction" type is employed.

Rate per Minute and Duration of Operation

The rate of operation should be about 12 a minute.

The lungs should be thoroughly emptied by three seconds of vertical pressure, in the manner described; then the hands are removed, and the refilling of the lungs takes care of itself.

Pressure and release of pressure—one complete respiration—occupies about five seconds.

This rate can be approximated by the operator following his own deep regular respiration, if he is alone; or by counting, or he can use his watch. If comrades are present, he can be guided by them.

Such efforts are usually successful within twenty-five minutes, but should be continued indefinitely, without interruption for any cause. One hour, even two hours or more, may be required to bring him to.

Supplemental Assistance

While the artificial respiration is being carried on, a second party should clear the mouth of all foreign material, then hold continuously a cloth saturated with aromatic spirit of ammonia near the nose. The collar and neck band may be loosened.

While this is being attended to, a third party summons the doctor.

No liquids dare be given by the mouth while the patient is unconscious. How would you like to have somebody give you a drink of water when you were asleep?

On the arrival of the doctor, he can stimulate the heart of the patient with such drugs as atropine and strychnine, and can direct the supplying of external heat, if there is

collapse, or the weather is cold; and he can direct the infliction of such pain as is deemed requisite, such as pulling the patient's hair, pounding him with a board, slapping, rubbing, stretching the sphincter ani muscle, pulling the tongue.

RESUSCITATION FROM ELECTRIC SHOCK, DROWNING AND ASPHYXIATION BY MEANS OF ARTIFICIAL RESPIRATION

Efforts at resuscitation must be begun without a moment's delay, the instant the patient is freed from the contact. Accidental shocks seldom result fatally if the victim is aided immediately and the efforts to resuscitate continued.

If the body is in contact with a conductor, a dry stick of wood or a dry piece of clothing should be used to remove the conductor or roll the body to one side. If the body is in contact with the earth, any loose or detached piece of clothing may be seized with impunity to draw it away from the conductor.

DIRECTIONS

I. The man is laid upon his stomach, face turned to one side, so that the mouth and nose do not touch the ground.

II. The operator kneels, straddling the patient's hips; or kneels by either side of the hips, facing the patient's head.

III. The operator places his spread hands upon the lower ribs of the patient and throws his own body and shoulders forward, so as to bring his weight heavily upon the lower ribs of the patient.

The operator's downward pressure should occupy about three seconds, then his hands are suddenly removed. Squeezing out the air in this manner creates a partial vacuum, and on release of pressure the air rushes into the lungs, the elasticity of the chest walls causing the chest to expand.

This act should be repeated indefinitely at the rate of about twelve times a minute—the danger is that in the excitement of the occasion, the rate will be too rapid. If the operator is alone with the patient, he can adjust the rate of the artificial respiration by his own deep regular breathing; if others are present, a watch can be used to advantage to regulate the rate. In all cases the efforts at resuscitation should be continued until the arrival of the physician. Any evidence of returning breathing should encourage the operator to continue his efforts. Artificial respiration should be continuous for one hour; much longer, if there are any evidences of returning animation.

1. SUMMON THE DOCTOR WITHOUT DELAY.
2. As soon as artificial respiration has been started, a second party may pull the hair, dash cold water in the face, loosen the clothing and collar and hold a cloth saturated with aromatic spirit of ammonia near the nose, or supply oxygen gas by means of a stiff paper cone attached to the tube and placed over the mouth and nose. The aromatic spirit of ammonia is considered more effective than the oxygen. Spanking the buttocks sharply may also have a quickening effect; pulling on the tongue helps bring the man to. See that the mouth contains no tobacco or spittle.
3. No stimulant nor liquids of any kind should be administered by the mouth while respiration is suspended. Keep back the crowd.

SUCCESES OF THE PRONE PRESSURE METHOD

Precautionary measures, such as carefully instructing all new men, the marking of switchboards, the placing of signs and fences in danger zones during tests, have materially reduced the number of cases of Electric Shock, but the few times the Prone Pressure method has been called into service, it has proven efficient.

It has been requested that brief notes be added on the cases that have come more or less under our observation. This record of success has been offset by one recent failure; in this case heart action was not restored, breathing was not re-established, after more than two hours of honest efforts at artificial respiration, combined with oxygen, and the supplemental measures outlined in this volume.

The preponderance of success over failure is due to the fact that hundreds of men in our establishment are instructed in this method, and when such an emergency arises, they are instantly "on the job." That an electrical

plant employing 13,000 men and upwards, doing extensive test work, averages but one such case a year, is a high tribute to the progress of the "Safety First" movement. Carelessness, the personal element, looms up large as a factor in these accidents, as in all others.

We contend that no modern industry, paying due regard to the value of human life, can be safely operated without instructing its employees in the proper procedure of the Prone Pressure method.

I. Nov. 11, 1910, "A" was resuscitated in section S1, W. E. & M. Co., by W. T. Mardorf. Three fingers of the right hand had deep third-degree burns, and respiration was suspended. He touched the connection on a switch-board with his fingers, while standing on an iron bed plate, being grounded through both feet, on a 2200 volt line. The Prone Pressure method restored respiration in twenty-eight minutes, and a few minutes later consciousness returned; the patient then stated that he "felt pretty good." After his recovery he was conveyed on a stretcher to the Relief Department, where his burns were dressed, and he was sent home in an ambulance; his burns disabled him until Dec. 5, 1910. File 7110.

II. July, 1913, "B," was resuscitated in section P-9, W. E. & M. Co., by E. V. Saunders

and C. W. Diehl. 8000 volt a.c., contact from hand to hand; left hand held the bare wire, while his right hand touched the connection. The contraction of his arm muscles folded his left hand over his breast, and he fell, still holding the wire in his clenched hand; his back came in contact with iron piping. Both hands were much burned, also the right forearm; there were burns the size of a spread hand on his chest and back. Loss of fingers ensued. Extensive skin grafting was required and there were months of disability. It was the ground contact that did the most damage; his nearest comrade, who saw him drop, took four steps to pick up the nearest block of wood, ran back the same distance, and knocked the wire out of his hand. The duration of the dangerous contact exceeded fifteen seconds. It required fifteen minutes of rhythmic effort at artificial respiration (Prone Pressure) to restore natural breathing, and longer before he was fully conscious. File 16572.

III. Sept. 11, 1912, "C," was resuscitated in section M-1, W. E. & M. Co., by Joseph Corbett, foreman. 600-volt a.c. contact was made, while cleaning cathode rods in the plating vats, his work being to hang jobs on the bent wire hooks suspended from the rods in the tanks. It occurred when starting work in the morning; he presumed all switches were

open, without any inspection. The night-turn man left the switch closed. When he got his hands in the vat and made contact, he yelled, and fell unconscious; the fall broke the contact. The foreman ran to him, got busy with Prone Pressure treatment, and in nine minutes he showed signs of life; in five more minutes he could breathe for himself. Five days' disability. File 10703.

IV. May 27, 1913, "D" a laborer from K-70 bringing a truck load of material to be tested in P-10, disregarded the danger signs, and was no sooner inside the fence, in the zone of danger, than a heavy static discharge from the wires, estimated at 180,000 volts, struck him. He was down and out instantly; he was apparently lifeless, his respiration was arrested. He was resuscitated by Charles E. Jones and W. F. McGuire, in nine minutes, by Prone Pressure, but he was dazed for a longer period. His disability covered six days. File 25721.

V. Jan. 25, 1915, Anthony Conroy was resuscitated on Oak Hill, East Pittsburgh, Pa., by Alfred Dunlap, an employee of W. E. & M. Co. One bob sled ran into another; Conroy was struck on the forehead, was rendered unconscious, and was not breathing. The boys spread their coats on the snow for Conroy, and Dunlap applied the Prone Pres-

sure. Someone brought water, and sprinkled it on his face, others rubbed his hands. In ten minutes of continuous rhythmic efforts, the artificial respiration brought him around, so that he could breathe naturally. He was much prostrated, so that they had to haul him home on a bob sled, and put him in bed, where he remained two days, and spent two more days in the house, before he fully recovered from the knock-out blow. Aside from a large dose of Epsom salts on the second day, he received no drugs.

This incident has several parallels, among cases reported to me by men who have been under my instruction.

VI. Feb. 16, 1914, "H" was resuscitated in East End, Pittsburgh, by C. A. Smith, Foreman Section U-1, W. E. & M. Co.

"The young man had attempted suicide by hanging. I was called in, and after he had hung for over ten minutes, I began work on him."

A doctor, who was summoned, pronounced him dead, but this doctor did not know the resources of the Prone Pressure method in strangulation and asphyxiation. Smith had faith: "After twenty minutes' work, I saw signs of life, but did not stop for about three-quarters of an hour, after which we sent him to a hospital.

" His condition when I found him was as follows: Eyes and tongue protruding, the whites of his eyes as red as blood, his face blue.

" Had it not been for the knowledge I gained from you, no doubt this young man would now be a corpse." Extracts from letter received Feb. 17, 1914.

VII. Dec. 18, 1911, " M " was resuscitated in Sec. D-2, W. E. & M. Co. by W. T. M. and W. C. W. He used a ladder in oiling his machine; on this occasion, the opening where he threw his arm for support had been covered up, and he fell heavily to the floor, striking the back of his head and lacerating his scalp. He was fifty-two years old and weighed 180 pounds. He was picked up unconscious, with no pulse and no respiration; the Prone Pressure was employed about fifteen minutes before signs of life were manifest. Hypodermics were administered, and all the supplemental methods of assistance, including stretching of the sphincter ani muscle, which was found relaxed. It was a clear case of concussion of the brain, and the man was apparently dead, positively dead if he had not been revived. After twenty minutes of Prone Pressure, he vomited, then consciousness returned, and spontaneous breathing was restored. He was conveyed on a stretcher to

the Relief Dept., where his scalp was sutured, and on an ambulance to the hospital; his concussion cleared up with two days' rest in bed. File 2837.

VIII. March 3, 1914, "X" was resuscitated by C. A. L. It was a case of collapse during chloroform anaesthesia; a cut tendon in a finger on being recovered and sutured, when a pallor crept over the face, the eyes rolled up, pupils widely dilated, respiration and pulse ceased. Prone Pressure was continued fully twenty minutes before any signs of life were manifest, and nearly that much more time before consciousness returned and normal breathing was restored. Strychnine, atropine, etc., were employed; it was a long interval before a radial pulse became perceptible. Inhalations of aromatic spirit of ammonia, flagellations, etc., were also employed.

IX. June 21, 1910, "Y" was resuscitated by R. D. G. and C. A. L. The child collapsed under a few whiffs of chloroform, given at the outset of the anaesthesia, in advance of the ether. The dread pallor came suddenly, there was no pulse and no respiration. Strychnine and atropine, previously prepared, were administered, and Prone Pressure was employed; in four minutes he breathed, and his pulse returned. After a

few more minutes of artificial respiration, until conditions became normal, ether was given, and the circumcision operation was performed without further mishap.

X. H. G. Stephens, Swimming Director in the Cleveland Y. M. C. A., under date of Jan. 26, 1915, wrote a letter, now in my possession, in which he says: "The true value of the little book (pamphlet on resuscitation) can never be estimated." He is an enthusiastic advocate of the Prone Pressure method, and has adequate reasons for his abounding faith: "As Swimming Director here since May, 1913, I have accepted fifteen drowning cases, and have been miraculously fortunate with such aid in bringing all cases to life."

Persons qualifying to own or operate sail boats, motor boats, skiffs and canoes, in the city of Cleveland, must present credentials of a practical working knowledge of the Prone Pressure method. Not only has Mayor Baker of Cleveland taken this stand on the issuing of boat licenses, but the Director of Public Safety, Alfred A. Benesch, has distributed booklets on Resuscitation, and arranged for the instruction of the men "who have charge of the emergency patrols." This attitude of their city government towards Prone Pressure has doubtless arisen from the record

of H. G. Stevens, of the Central Y. M. C. A., and his advocacy of this method. Cleveland's progress in this respect is commendable; let other cities do likewise.

HERO MEDAL RECOMMENDED *

Prone Pressure has not enjoyed the publicity afforded by a press bureau, as has the pulmотор and the lungmotor, but can present splendid records of successful achievements.

In a paper read at the Sagamore, Lake George, before the Eastern New York Section of the National Electric Light Association, September 15, 1913, the author voiced the opinion that a clearing house for the investigation of bona fide cases of Resuscitation from Electric Shock, and allied conditions, should be established under the auspices of that organization, or under the joint auspices of all the electrical societies.

Cases of neglect and failure could be recorded, and successes achieved under every method of artificial respiration would go on record, and the results could be tabulated. By such compilation of the universal progress of world events in this field, successful experience will stimulate others to like achievements, and will tend to standardize the best

* See Article by Chas. A. Lauffer, M.D., in The Electric Journal, Vol. X, No. 12, p. 1276.

practice. The best experience should be universalized.

The writer suggested also the presentation of bronze medals to the men who resuscitate comrades from electric shock. "Such a medal could be worn on a watch fob, or otherwise. It would be inexpensive to the Association, the intrinsic value of the badge being insignificant in comparison with the appreciation of every recipient of such a gift. It would be a badge of honorable distinction, and the distribution of such awards would doubtless contribute more to the propaganda for right methods of artificial respiration than it is possible for those of us to attain, who use our pens, our voices and our arms, in describing and in demonstrating the Prone Pressure method."

